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ABSTRACT

The purpose of this study was to determine the effect of computer assisted instruction (CAI) on the cognitive and affective development of college students enrolled in a principles of macroeconomics course. The hypotheses of the experiment were stated as follows: In relation to the traditional principles course, the experimental treatment will result in (1) no loss in general cognitive capabilities of the students; (2) superior analytical capability; (3) and more favorable student attitudes toward economics. The experimental design for the course emphasized the substitution of CAI for the traditional lecture-textbook approach. It involved two instructors each teaching a control and an experimental section. The experimental sections differed from the control sections in that the students were exposed to CAI materials which included tutorial lessons and simulations. The results indicated that exposure to integrated CAI materials had a significant positive effect on basic analytical ability. However, the materials were not able to produce significant results across all question types on a general cognitive instrument. Furthermore, the affective results clearly indicated no effect. In accounting for these results, it is pointed out that the CAI materials were not uniform, that they were optional, and that the data base was relatively small. (Author/JK)

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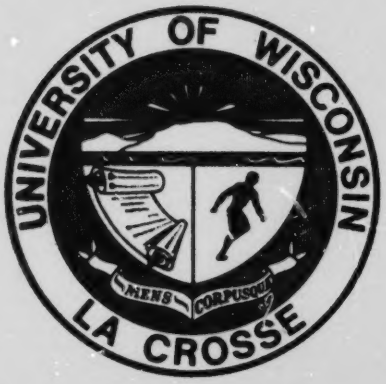

La Crosse, Wis. 54601

STUDIES IN ECONOMIC EDUCATION

AN EVALUATION OF THE COGNITIVE AND AFFECTIVE PERFORMANCE OF AN INTEGRATED SET OF CAI MATERIALS IN THE PRINCIPLES OF MACROECONOMICS

SP 010 636

by

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Study No. 4

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PART 1. INTRODUCTION

BACKGROUND

Computer assisted instruction (CAI) has become increasingly popular over the past decade. Many disciplines, notably the more quantitatively oriented, have taken steps to integrate the computer into their courses. Progress in CAI in undergraduate education is periodically highlighted in CONDUIT's State of the Art Reports (7).

The economics profession has become interested in CAI because many economic models can be expressed as a system of equations and as such, model behavior may be numerically simulated on the computer. For instructional purposes this alternative to the traditional graphic approach has certain advantages. In particular, it allows for the manipulation of more realistic and complex models. This advantage is especially marked with respect to dynamic analysis. Progress in undergraduate economics education computer use is documented in John Soper's extensive review article in the Fall, 1974 issue of the Journal of Economic Education (29).

While instructional computing may appear to be a logical method for the teaching of economics, especially in the area of economic theory, it is not entirely clear as to what use the profession has made of learning principles for the purpose of analyzing and efficiently utilizing this alternative. It is one thing to simulate an economic model on a computer, and quite another to shape such a capability into a worthwhile educational experience for the student. In it's brief history of computing in economic education the CONDUIT staff writes:

> It is not clear that these models were designed to meet any specific learning problems or were geared to essential economic concepts. Perhaps these models were just easy to program and met a need to "use the computer" (7, p. 110).

One clear shortcoming of existing CAI materials is their lack of continuity. That is, there is a wide variety of instructional programs which exhibit large differences in educational quality and approach. Examination of these materials suggests that they were developed on a piecemeal basis by many different authors. There are only a few sets of materials that are integrated in the sense that they span the entire subject matter of a course and are based on a uniform CAI technique.[1] Moreover, the success of many CAI materials has been judged on the basis of impressionistic evidence. That is, many CAI materials have not been tested in a controlled situation.

Frustrated by the lack of a complete CAI package, and spurred by the relatively high quality of instructional computing hardware and support available at the University of Wisconsin-La Crosse, the authors developed and tested an integrated set of interactive tutorial lessons and simulation games for use in the principles of macroeconomics course. The basic concept is quite simple. Students are enrolled in a "course" consisting of tutorial lessons and simulation games which are "managed" by a control system of programs and files. As students proceed through the course their performance is automatically recorded and subsequently reported to the instructor.

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[1] Notable examples of these limited integrated materials are the macroeconomic simulations of Steve Cox(8) and the materials developed by Bonello et. al. at Notre Dame (10).

In assessing the worth of the CAI materials created by the authors, three evaluation criteria were considered. First, did the students exposed to the innovative mode of instruction "learn more" and/or "like it better" than the traditional mode of instruction.[1] Second, did the new approach cost the same as the traditional alternative while producing greater "learning" and/or "liking"? Did it cost more while producing less, and so on? This type of criterion relates to relative cost and is the legitimate domain of the economist. Third, did the students retain what they learned longer with the new approach than with the traditional alternative?

This paper focuses on the first evaluation criterion, i.e., the cognitive and affective performance of the students exposed to the materials, while a following paper examines the second criterion, which broadly may be called the cost effectiveness of the materials (9). At present further analysis of the third criterion, retention, is not planned.

The materials were implemented in a quasi-experimental context during the 1974 Fall semester. It was thought that the materials would have a dual effect in that they would foster the analytical ability of the student, and have a positive impact on student attitudes toward the subject matter of economics. Greater analytical ability was anticipated

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[1] Actually observable human behavior has been divided by education psychologists into three taxonomic structures: (1) cognitive domain - deals with knowledge and developed intellectual abilities and skills, (2) affective domain - classified interests, attitudes, values, appreciations and psychological adjustment, and (3) psychomotor domain - deals with manipulative or motor skill aspects of behavior (22, p. 111).

because tutorial lessons and simulation games would, unlike classroom lecture, encourage each student to focus on and actually participate in particular logical sequences. Similarly, improved student attitudes were expected for the same reason, i.e., because simulation game activities require active, rather than passive, student roles.

Given the above cognitive and affective expectations, the maintained hypotheses of the experiment may be stated as follows:

> In relation to the traditional principles course, the experimental treatment will result in
> 1. no loss in general cognitive capabilities of the students;
> 2. superior analytical capability;
> 3. and more favorable student attitudes toward economics.

Following a section describing the conditions of the experiment and the basic characteristics of the statistical model employed to test the maintained hypotheses, the paper is divided into two main parts. The first part considers cognitive performance and presents the test results of the first two hypotheses. The second part considers affective performance and examines the experimental treatment in relation to the last hypothesis.

EXPERIMENTAL DESIGN

The experimental design for a three credit introductory economics course emphasized the substitution of CAI for the traditional lecture-textbook approach. It involved two instructors each teaching a control and an experimental section. The experimental sections differed from the control sections in that students were given the opportunity to use the computer. The design was quasi-experimental in the sense that the control

and experimental sections did not have pre-experimental sampling equivalence. That is, students were not randomly assigned to individual sections, but rather they selected a given section primarily on the basis of scheduled class times. Each instructor's experimental section, however, was randomly assigned. There was no explicit information provided to the students, either prior to registration or during the semester, regarding their participation in an experiment.

Students in the experimental sections had access to a Hewlett-Packard 2000C' time-sharing system through thirteen terminals on campus. Each week, students in the CAI sections were presented with a "menu" which consisted of tutorial lessons, games, and simulations. Students were allowed to select freely from the weekly menus, but were encouraged to proceed through the weeks in chronological order and, within a week, to begin with the lowest numbered lesson, game, or simulation. Tutorial lessons were completed on an individual basis while simulation games could be played on an individual or team basis (consisting of a maximum of four players to a team). Throughout the semester, students had the opportunity to complete fourteen tutorial lessons, five games and one simulation. The computerized games and and simulation were written in Beginners All-Purpose Symbolic Instruction Code (BASIC) language and the computerized tutorial lessons utilized Hewlett Packard's Instructional Dialogue Facility (IDF).[1]

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[1] IDF enables an instructor with no programming knowledge to write lessons for presentation to students at computer terminals. For further information see reference (15). The original materials have been transferred from the HP2000C' to the HP ACCESS System. They are continually being updated and revised on the basis of our student experience. The complete set of revised CAI materials (including the control package which routes, records, and reports student CAI activities) can be obtained from the Center for Economic Education, University of Wisconsin - La Crosse, La Crosse, Wisconsin 54601.

The four sections in the experimental design met in the same classroom during the 1974 fall semester. The control section of instructor A met for fifty minute periods on Monday, Wednesday and Friday at 1:00 P.M. while his experimental section met for fifty minute periods on Monday and Wednesday at 2:00 P.M. The Friday period was considered released time which students could utilize as they wished.[1] The control section of instructor B met for seventy-five minute periods on Tuesday and Thursday at 2:00 P.M. while his experimental section met for fifty minute periods on Tuesday and Thursday at 3:30 P.M. These shortened periods amounted to fifty minutes of released time per week resulting in similar released time for students in both experimental sections, but under different conditions. On several occasions, the weekly released class time was suspended due to exams or other extra-ordinary circumstances.

Both instructors attempted, as much as possible, to standardize classroom activities and grading policy. For example, class attendance was recommended, but not required. The same textbooks were used in all sections. Exams consisted of a common core of multiple choice items drawn from the UW-L Economics Principles Test Bank[2] and additional items selected by each instructor on an individual basis.

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[1] If desired, students could have attended unstructured discussion sessions with the instructor during the released time.

[2] The UW-L Test Bank currently consists of over 2000 test items and is used by all instructors teaching principles of economics. Each item, when used by an instructor, is processed through an item analysis program by the UW-L Computer Center. The program provides a distractor, item difficulty, and item discrimination analysis for each item on an exam, as well as standard exam summary statistics.

Grades were based on total accumulated exam points. In addition, a maximum of ten bonus points could have been earned and were added to accumulated points after the grade boundary lines were drawn. Thus, the bonus points conceivably made it possible for a student to advance to a higher course grade. Bonus points were earned by students in the control sections by completing specified tasks outside the classroom. In the experimental sections, bonus points were earned by students primarily for undertaking CAI oriented tasks.

Finally, extreme care was taken to maintain the same incentive structure for all participants, control and experimental alike. Incentive structure refers to the conscious incentive framework within which the student performs on the test instrument. For example, one of the most important elements in this structure is whether or not the score on the test instrument will have a bearing on the student's course grade. In this respect it may be presumed that the incentive structure has an impact on the effort expended by the student in taking the test instrument, and consequently on the degree to which the test score is a valid measure of ability. In general, the impact of the incentive structure on the validity of the test score as a measure of ability has been completely ignored in economic education studies dealing with evaluation.

THE GENERAL STATISTICAL MODEL

A primary objective in the analysis of a new instructional approach is the identification of a causal relation between the new approach and a change in student performance. With this in mind, both the experimental design and statistical procedures were oriented toward such an

identification. In the experimental design, student subjects were divided into experimental and control groups, between which the only intended difference was experimental treatment. If there were no other difference between the two groups, the CAI materials could have been evaluated simply by a statistical test for difference in mean performance between the groups. However, since other differences are nearly always present, the statistical model used was least squares multiple regression. The model is as follows:

$$Y = a_o + \sum_{i=1}^{n} a_i X_i + bZ + e$$

where

Y = performance measure

X_i = control variable ($i=1, \ldots, n$)

Z = zero-one variable representing experimental treatment

e = error term

This statistical model was used for two reasons. First, the model, assuming it was appropriately specified, would statistically control for possible differences in variables between the experimental and control groups. Of course, such control served to test the isolated effect of experimental treatment in terms of the statistical significance of the coefficient on the dummy variable. It is noteworthy that such control is desirable even if the student subjects had been randomly assigned to the treatment groups because even with random assignment, the laws of probability assure us of occasional mismatched groups. Second, provided the statistical prerequisites for the model are satisfied, statistical analysis would allow for the determination of the non-experimental treatment factors that contributed to performance. This determination would depend on the statistical significance of the coefficient associated with each control variable.

PART 2. THE COGNITIVE DOMAIN

RESEARCH IN ECONOMIC EDUCATION: THE COGNITIVE DOMAIN

In the economic education literature relating to learning performance in the cognitive domain there are two interrelated issues that arise in the context of the multiple regression approach. These issues are the specification of the cognitive performance measure (Y), and the specification of the control variables (X_i).

The Dependent Variable and Cognitive Performance

The most commonly employed measure of cognitive achievement in the college introductory economics course is the Test for Understanding in College Economics (TUCE) (34). The TUCE is a validated, nationally normed exam available in pre- and post-test form for the principles of either macro or micro economics (5, 21).

Prior to a paper by Gery (14) the post TUCE score was often directly used as the dependent variable. Gery argued on logical grounds that if this was done without controlling for pre-course knowledge of economics, then conclusions regarding the performance effects of experimental treatment were rendered suspect due to lack of control for what Gery called "starting gate" differences between student subjects. One solution to this problem was to include pre-TUCE score specifically as a control variable representing pre-course economic knowledge. However, on statistical grounds he went on to argue that this approach was inferior to using a pre to post improvement factor as the dependent variable. The improvement factor Gery found most desirable was the proportion of the

pre to post TUCE gap closed.[1] After converting to the improvement model, Gery found that the coefficient associated with pre TUCE score as a control variable lacked statistical significance.

The Independent Variables

Relative to the number of studies actually undertaken to assess the cognitive performance of alternative teaching techniques in economics, precious little attention has been devoted to conscious development of a structural model of cognitive achievement. Very few studies have explicitly developed the rationale for the theoretical model (in particular the selection of the explanatory or control variables) actually employed in multiple regression analysis. Notable exceptions are studies by Dahl and Lewis (20), Gery (13) and Bonello, Davisson and Jameson (4).

Dahl and Lewis make a distinction between variables determining pre TUCE score and post TUCE score. They hypothesize that pre TUCE is a function of four student characteristics:

1. General ability (grade point average, ACT score)
2. Motivation (pre course attitude toward economics)
3. Media exposure (reading of business and economic publications)
4. Special background (major, class standing, high school economics, sex.)

They attempt to identify certain other important factors which along with the initial student characteristics serve to determine post TUCE scores,

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[1] Proportion of pre to post TUCE gap closed = $\frac{\text{Post-Pre}}{33 - \text{Pre}}$

Where 33 is the maximum score in either pre or post test.

namely those variables relating to the instructional process and student effort. Among variables related to the instructional process are:

1. Instructor characteristics
2. Textbook
3. Class size
4. Post course student attitude

Student effort is simply measured in terms of the amount of time students profess to spend studying for the course.

In a similar manner, Gery also makes a distinction between those factors effecting the pre and post TUCE scores. He groups the independent variables into three categories:

1. Control
2. Motivational
3. Explanatory

Control variables such as age, class standing, high school rank, sex and high school economics are seen as primarily determining pre TUCE score. In turn, this prior economic knowledge serves as a partial determinant of post TUCE score. Motivational variables (attitudes toward the subject matter, text, course and instructor as well as student effort) and explanatory variables (verbal, quantitative and critical thinking aptitude) are viewed as affecting pre TUCE score with a "marginal" effect on post TUCE score.

Presumably the term "marginal" refers to an independent effect separate from the indirect influence through the pre-TUCE proxy for prior economic knowledge. In view of the hypothesized structural model, Gery postulates that the proportion of TUCE gap closed is directly a function of these three sets of factors and pre-TUCE score is dropped out.

Bonello, et. al. specify a more general model not specifically related to the TUCE. They hypothesize that cognitive achievement is a function of:

1. Human capital
2. Utilization rate
3. Efficiency

Human capital refers to such general ability characteristics as scholastic aptitude scores and high school rank. Utilization rate relates to the extent that the student actually utilizes his ability in time spent attending class and generally studying the subject matter. Finally, cognitive achievement or performance of students with comparable ability and utilization rates may differ on account of differences in the quality of their effort. That is, some may be more efficient in their study techniques.

The Integrated Model of Cognitive Performance

Inspection of the above models reveals common elements as well as distinct differences. Bonello, et. al. (4, p.22) note that "factors ... operative in producing educational output ... all center on or are channeled through the student." Clearly it is the student that does or does not exhibit cognitive achievement. Consequently, student characteristics should logically be an important determinant of such achievement. However, it is the instructional process through which learning is intended to take place. While an interaction between these factors having an effect on cognitive performance is likely, they should be explicitly recognized as distinct although not independent, i.e.

$$CA = f(SC, IP)$$

where

CA = cognitive achievement

SC = student characteristics

IP = instructional process

The Dahl and Lewis paper makes an explicit distinction between SC and IP, while the other two do not.

In terms of student characteristics, the models appear to identify five distinct categories and one residual category:

1. General cognitive ability
2. Prior economic knowledge
3. Maturity
4. Motivation
5. Effort
6. Other (sex and major)

General cognitive ability is associated with a student's verbal, quantitative or critical thinking aptitude. Prior economic knowledge may be related to previous formal academic work in economics or non-formally acquired knowledge from periodicals or newspapers. Maturity is very difficult to define and/or measure, but it is customarily associated with age or college class. Motivation is measured in terms of student attitude toward the subject matter before and after the instructional process, while attitudes toward the instructional process are measured only in a post sense. The post process attitudes, as they relate to motivation, are thought to be an important source of interaction between the instructional process and cognitive achievement as "channeled

through" a student characteristic. Effort is related to the amount of time students spend studying as well as the efficiency with which they utilize their time. Finally, the residual category includes those specific variables that empirical work has found significant but are not readily associated with the five specific categories.

In terms of the instructional process, three categories may be identified:

1. Instructor characteristics
2. Classroom environment
3. Instructional approach

Instructor characteristics include such things as the extent of his training in the subject matter, his attitude and values in relation to the subject matter, and generally the skill with which the material is presented to the students. Classroom environment relates to the physical characteristics of the instructional setting such as class size. Finally, the instructional approach is determined by the delivery system and technology employed. For evaluation, the experimental design and statistical procedure are used to isolate and measure the independent effect on cognitive performance of this last category of the instructional process.

STATISTICAL RESULTS

Selection of Dependent Variables

In considering measures of cognitive achievement (i.e., dependent variables) we chose to include the TUCE gap-closing models and the absolute level post-TUCE models. This decision was based on Gery's arguments (14) and in the interest of comparing our results with studies

using these different TUCE models. In addition, as an independent backup for the TUCE models, exam-points-in-common models were included.

Prior to the beginning of the semester, the instructors selected 142 common items for two semester exams and a final exam from the UW-L Economics Department Principles Test Bank. A comparison of the regression results for corresponding post-TUCE and TUCE gap-closing models indicates that the signs of the coefficients, associated with the given independent variables, remained virtually unchanged and the t-values maintained the same relative magnitudes. In addition, the exam points models confirmed our TUCE regression results.

Questions on the TUCE exam have been grouped into three "objective" categories.[1] To correspond with these TUCE subparts the exam items used in common were also classified as either recognition and understanding or application (AP). The application subpart consisted primarily of SA items with a few CA items. Student performance within these separate subparts was also considered as a dependent variable in order to separately test the maintained cognitive hypotheses of this study. Recall from the introduction that these were, respectively, no loss in general cognitive capability and superior analytical capability on the part of those students exposed to our CAI materials. The TUCE RU grouping clearly serves to test the first hypothesis. The choice of which application grouping to employ in testing the second hypothesis is dictated by the conclusions of Lewis and Dahl (21, p. 155).

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[1]These categories are recognition and understanding (RU), simple application (SA), and complex application (CA) -- see (34).

> ...when associating the three subparts of TUCE with critical thinking skills as measured by the Watson-Glaser Critical Thinking Appraisal (CTA), the most significant associations occur with the 'simple application' and not the 'complex application' types of questions. In fact, the complex application questions in TUCE show minimum association with critical thinking skills.

Therefore, the SA grouping serves to test the second hypothesis.

The integrated model presented in the previous part outlines six theoretical categories of factors thought to contribute to cognitive achievement. These factors must be controlled in order to assess the independent effect of an alternative instructional approach. The next section describes the process used to select this set of control variables.

Selection of the Independent Variable Set

The selection and use of operational proxies for the integrated model categories proved to be difficult for a number of reasons. First of all, some highly correlated independent variables were a problem because the greater the degree of multicollinearity, the more arbitrary the assignment of the explained variation among individual explanatory variables, and the less confident one can be about conventional tests of significance. A second problem was the absence or unavailability of certain critical data, such as the generally used cognitive ability proxies, ACT and SAT. These tests were not required by UW-La Crosse and class time could not be allocated for additional tests to obtain these measures. Finally, recent legislative concern and administrative rulings have moved disclosure and use of personal student data into the potentially troublesome legal arena. This served to further restrict the use of some operational proxies.

All of the various cognitive achievement models presented below incorporate what may be referred to as the "standard set" of independent variables. These variables were selected within the constraints outlined above to serve as proxies for integrated model categories. A discussion of these variables by category follows.

General Cognitive Ability

Numerous studies of cognitive performance in economics have used ACT or SAT scores either implicitly or explicitly as a proxy for general cognitive ability (e.g., 11,20,26,32). Another proxy, high school rank (HSRANK)[1] has been considered and downgraded because it is argued that: Somehow, a student in the ith percentile from a 'good' school will be superior to a student in the same percentile from a 'bad' school, and therefore high school percentiles are not directly comparable (32,p. 8). In the absence of ACT or SAT scores we had no real choice in the proxy selection for this category. Consequently, we were virtually forced to rely on high school rank for this important category.

Fortunately, however, use of high school rank can be justified on grounds other than desperation. First, consider the problem of different quality high schools. Although we have no data relating to high school quality differences, we conjecture these differences for our student population are slight and may be related to high school size. An interaction term relating high school size and high school rank contributed significantly to pre-TUCE variation, but under a variety of models, contributed virtually nothing toward explanation of variation in the measure of cognitive performance. Consequently, we hypothesize differences in high school quality as they pertain to our study are primarily reflected through the pre-TUCE.

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[1]Definitions and associated abbreviations for all variables are presented in Appendix A.

Second, HSRANK may represent information related to collegiate cognitive performance that is not contained in ACT or SAT scores, or in other control variables specified in the integrated model. Cognitive performance in the early college years may be more closely related to a student's perception of where he or she ought to be, based on high school experience, rather than to a measure of pure intelligence -- if such a measure existed. If this is true, then HSRANK may actually be operationally superior to SAT or ACT scores in accounting for variance in cognitive performance.

Finally, educational psychologists do not appear to share the assessment of HSRANK as an ability measure that is expressed in (32).[1]

Prior Economic Knowledge

Two measures of prior economic knowledge were considered: high school economics (HSEC=1) and pre-TUCE score (PRETUC). High school economics, as a measure of previous economic knowledge, was rejected because of what was considered to be unreliable data. Students were asked at the beginning of the semester to list whether they had economics in high school and the name of their instructor. It was felt that responses to this question although honest, were erroneous, since what is called 'economics' in high schools can consist of anything from American Problems to Zoology, depending upon the training of the teacher. However, if high school economics does have some effect on cognitive achievment it probably would be reflected in the pre-TUCE variable, PRETUC.

Aside from its correlation with cognitive ability and the incidence of high school economics, PRETUC has an interesting indepenent effect

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[1] For example, David Lavin suggests that "it is conventional to use high school grade as an ability measure. However, it should be noted that ability is not the only factor determining the high school record. Numerous personality and social factors are involved (19, pp. 51-52).

on cognitive performance when performance is measured via the gap-closing approach. We will call this the "end-hill" effect. The meaning of the "end-hill" effect is quite simple. By analogy, imagine first a group of untrained runners attempting to travel as far as possible along a flat track of a given distance during a specified time interval. Their initial performance is measured and recorded. After training, the race is rerun and performance measured. Gery asserts the proper measure of training effectiveness is the gap-closed and the gap-closed is free of inherent bias because each student (runner) has the same gap to close -- 100%. He found pre-TUCE to be an insignificant explanatory variable for gap-closed (14). We maintain the runners (students) are not competing on a <u>flat</u> track, but are competing on a track with a <u>steep hill</u> at the end. The hill becomes so steep at the very end, that while the fastest runners are struggling slowly to the finish line near the end of the time interval, the less capable runners who have not reached the steepest part of the end-hill are still making fairly decent progress when the race ends. We hypothesize that because of the dispersion of item difficulty on the TUCE, the end-hill effect will be evident. Operationally this hypothesis means that students who have a smaller absolute gap to close (but nevertheless a 100% gap) will average smaller % gap closed than those with a larger absolute gap.

PRETUC is used as the pre-measure when the dependent variable is the sum of all three subparts; TUCE objectives, i.e., recognition and understanding, simple application, and complex application. But when the individual cognitive objective measures are regressed on the set of independent variables, the corresponding pre-objective subpart score (PRETRU, PRETSA, or PRETCA) is substituted for PRETUC.

Maturity

Three variables, age (AGE), total university credits (TOTCRE), and married (MARR=1) were considered as proxies for maturity. We initially included age as the primary variable. Age was finally selected as the sole measure of maturity after it was discovered through experimentation that total credits added virtually nothing to the explanatory power of the equation when included with age, and detracted significantly when substituted for age. In addition, the 'married' variable presented a collinearity problem, i.e., age and being married were highly correlated (.65). Including both variables resulted in biased and inconsistent parameter estimates. Age proved to be the better of the two in explaining variation in the various cognitive performance measures.

Motivation

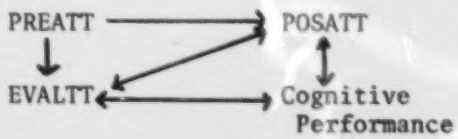
Three motivation proxies, pre-attitude toward economics (PREATT), post-attitude toward economics(POSATT), and a course evaluation composite (EVALTT) were considered, and only the last retained. The Karstensen 10 item attitude instrument (16,17), administered in pre- and post-modes, provided the basis for a 10-50 point summated attitude scale, where 50 represents the maximum favorable attitude toward economics.

A second instrument was formed by drawing twenty-four items from the Illinois Course Evaluation Questionnaire (1) and a mandatory summary instructor evaluation item from the UW-L Student Evaluation of Instruction Instrument.[1] This instrument provided the basis for

[1]The attitude and evaluation instruments are in Appendix B.

a 25-101 summated evaluation scale, where 101 represents the most favorable evaluation. The Illinois researchers classified their evaluation instrument's items according to components such as method of instruction, general course attitude, etc. We chose to use only the over-all sum because of the high correlations among component scores.

Our data and simple correlation statistics support the existence of the simple sub-model diagramed below,



where initial attitude toward economics plays a significant role in determining course evaluation by students[1] and post attitude toward economics, but not cognitive performance. Both post attitude toward economics and student evaluation of the instructional process are highly correlated (.70), which indicates the degree to which student feelings toward a course are intertwined and subject to what psychologists call a "halo" effect.

On the basis of this sub-model, we excluded pre attitude and tested the power of the other two variables to explain variation in the dependent variables. Employing both was ruled out because of collinearity, and course evaluation was retained as the better predictor of the two.

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[1]There are some interesting implications for instructor evaluation, expecially when such evaluations have a bearing on such things as merit pay raises, retention and tenure considerations. These implications will be pursued in a later paper.

Effort

Our consideration of the effort variable represents only a meager attempt to get at what should come naturally for economists. With few exceptions (2, 25, 33), discussions of effort and the resulting substitutions given a change in the students' choice set have been largely bypassed in the literature. Students, when presented with a learning alternative such as CAI, can conceivably: 1) increase their knowledge of economics because increased interest dictates more time for economics and less time for other things; (2) increase learning efficiency (i.e., learn more about economics without additional study time; or (3) devote less time to economics, maintain a satisfactory understanding or grade level in economics, and reallocate the additional time to other activities. All that can be said at this time is that very little is known about these substitutions, and serious evaluation of alternative learning technologies must involve their consideration.

The comments above reflect the authors' re-thinking subsequent to the experiment and data collection. Consequently, only two effort variables, current credits (CURCRE) and hours worked at an "outside" job were considered. It was felt both variables represented alternative and competing uses for a student's time and would be readily available with little measurement error.[1] CURCRE was included, but hours worked was not used because of incomplete data. Furthermore, an analysis of the observations with available work data (65% of total observations) indicated the expected high positive correlation between

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[1]Other studies (e.g., 20) have attempted to gather actual student hours spent studying economics, but the data must be suspect because of a tendency for students to misjudge time spent and because of lack of an efficiency measure.

age and hours worked and negative correlation between current credits and hours worked.

Other

Other variables frequently mentioned in the literature and found to contribute to cognitive performance were included. These were a sex dummy (SEXF=1) and three university major classification (0,1) dummies, School of Business (SBAM=1), lab science- including math- (LABM=1) and social science (SSM=1). Since the Economics Department at UW-La Crosse is currently contained within the School of Business Administration, economics majors were included within the first dummy.

Simple Tests of Difference Between Means

Table 1 contains experiment and control means, mean differences, and t-tests for the set of independent variables and for several other variables which were considered, but not included, in the regression analysis. Although the distribution as well as the mean of each characteristic may have some bearing on the dependent variable, the data in Table 1 indicate very few differences between experimental and control groups. Only one variable exhibits a statistically significant mean difference: pre-complex application. The significance of this mean difference underscored the need to control for prior conditions in order to assess and test the independent impact of the experiment.

Table 2 displays the mean difference between the experimental and control sections and the simple t-test of that difference for each dependent variable. Since Table 1 indicates a similarity between experimental and control student characteristics, the mean difference

TABLE 1

Simple test of difference between control and experimental section means for independent variables included in cognitive performance models, and other student characteristics.

Variable	Means		Difference	t
	Experiment	Control	(Exp-Con)	
HSRANK	63.70	66.25	- 2.25	- .85
HSEC=1	.37	.42	- .05	- .50
AGE	19.57	19.44	.13	.27
EVALTT	68.77	68.51	.26	.09
CURCRE	14.79	15.11	- .32	- .85
SEXF=1	.25	.28	- .03	- .37
SBAM=1	.34	.46	- .14	- 1.27
LABM=1	.16	.12	- .04	.57
SSM=1	.09	.05	.04	.75
TOTCRE	15.11	17.26	- 2.15	- .49
HSSIZE	4.36	4.56	- .20	- .87
MARR=1	.07	.04	.03	.85
PRLATT	39.93	39.16	.77	.83
PRETUC	11.21	11.04	.17	.27
PRETRU	4.39	4.44	- .05	- .14
PRETSA	3.50	4.00	- .50	- 1.63
PRETCA	3.32	2.60	.72	2.28*

*Reject the Null hypothesis of no difference at the 0.05 significance level. Critical t values (d.F.=111) for a two-tail test are:

Significance Level	Critical t
0.1	1.66
0.05	1.98
0.01	2.62

TABLE 2

Simple Test of Difference Between Control and Experimental Section Measures of Cognitive Performance

Variable	Means		Difference (Exp - Con)	t
	Experiment	Control		
%GCTUC	35.90	30.50	5.40	1.29
%GCRU	46.63	39.46	7.17	1.19
%GCSA	31.05	6.30	24.75	4.23*
%GCCA	27.99	37.05	- 9.06	-1.59
POSTUC	18.95	17.82	1.13	1.16
POSTRU	7.46	7.33	.13	.38
POSTSA	5.77	4.68	1.09	2.63*
POSTCA	5.71	5.81	- .10	- .23
EXAMTT	87.62	88.46	- .84	- .25
EXAMRU	62.05	64.07	-2.02	- .85
EXAMAP	23.50	22.30	1.20	1.13

*Reject the null hypothesis of no difference at the 0.05 significance level. Critical t values are equivalent to those for TABLE 1.

tests should be and are, similar to the full model tests below. In addition, Table 2 reveals the existence of a significant difference in simple application and no significant difference in recognition and understanding. This is of special importance to the study and is fully discussed below within the context of the complete model.

Regression Models

Table 3 contains the eleven model parameter estimates along with the t-values and R-squares. Further discussion of the statistical results is presented in four main sections according to the nature of the dependent variable. The first section compares the 'summated' models, #s 1,5, and 9; and discusses the role of each independent variable within the integrated model of cognitive achievement. The remaining sections deal with each of the objective subpart models in turn, discuss certain interesting features of the integrated model variables, and present the tests of the primary hypotheses.

Summated Models: 1,5,9; %GCTUC, POSTUC, and EXAMTT

In a sense, it is comforting that the results of the whole TUCE and exam point models are not at variance with most published studies. Models 1,5, and 9 contain no real surprises. First, in all three models, the measure of cognitive ability, HSRANK, is highly significant. This is consistent with other studies that use ACT or SAT instead of high school rank. Students who in the past have exhibited superior ability to perform well within an academic environment continue to do so in introductory economics.

TABLE 3

COGNITIVE PERFORMANCE MODELS

(t-values in parentheses)[e]

Model Number	Dependent Variable	Adjusted R^2	Independent Variables											
			HSRANK	PRE-	AGE	EVALT.	CURCRE	SEXF=1	SBAM=1	LABM=1	SSM=1	INSI=1	EXP=1	Constant Term
1	%GCTUC	.411	0.39 (4.92)	-1.53[a] (-3.02)	1.33 (1.94)	0.44 (3.74)	0.90 (1.04)	-11.25 (- 2.79)	-5.33 (-1.40)	-2.32 (- .46)	8.42 (1.21)	19.99 (5.74)	3.54 (1.07)	-50.76 (- 2.39)
2	%GCRU	.299	0.44 (3.59)	-6.45[b] (-4.25)	1.28 (1.19)	0.42 (2.35)	0.54 (.40)	-12.63 (- 2.01)	.79 (.13)	-6.08 (- .76)	-13.12 (- 1.19)	18.96 (3.45)	6.47 (1.24)	-26.37 (- .78)
3	%GCSA	.412	0.39 (3.30)	-7.25[c] (-4.47)	1.96 (1.90)	0.35 (2.04)	1.19 (.92)	-8.54 (-1.42)	-4.46 (- .81)	19.00 (2.51)	15.00 (1.44)	25.29 (4.84)	17.64 (3.52)	-80.12 (- 2.52)
4	%GCCA	.378	0.34 (3.13)	-8.20[d] (-5.66)	1.11 (1.15)	0.60 (3.70)	1.33 (1.10)	-12.07 (- 2.14)	-8.24 (-1.54)	-11.30 (- 1.60)	11.76 (1.19)	20.38 (4.18)	-5.43 (-1.15)	-47.41 (- 1.60)
5	POSTUC	.501	0.08 (4.67)	.30[a] (2.78)	.27 (1.87)	.09 (3.79)	.20 (1.12)	- 1.87 (- 2.20)	-1.03 (-1.28)	- .40 (- 0.38)	1.75 (1.19)	4.07 (5.54)	.65 (0.94)	- 6.16 (- 1.37)
6	POSTRU	.390	0.03 (4.83)	.28[b] (3.52)	.06 (1.11)	.03 (3.07)	.02 (.24)	- .98 (- 2.98)	- .13 (- .43)	- .33 (- .79)	- .12 (- .21)	.97 (3.37)	.09 (.33)	.56 (.31)
7	POSTSA	.451	0.03 (3.52)	.26[c] (2.48)	.14 (2.07)	.03 (2.49)	.12 (1.42)	- .52 (- 1.33)	- .56 (-1.53)	.94 (1.92)	.95 (1.40)	1.59 (4.70)	.99 (3.05)	- 5.00 (- 2.43)
8	POSTCA	.277	0.02 (2.67)	.17[d] (1.55)	.08 (1.11)	.04 (3.33)	.07 (.77)	- .46 (- 1.09)	- .42 (-1.02)	- .98 (- 1.84)	.80 (1.08)	1.52 (4.12)	- .36 (-1.01)	- 1.75 (- .78)
9	EXAMTT	.417	0.37 (6.02)	.76[a] (1.91)	.81 (1.50)	.31 (3.42)	- .19 (- .27)	- 8.58 (- 2.73)	-3.28 (-1.10)	4.05 (1.02)	-4.80 (- .88)	- .57 (- .21)	- .83 (- .32)	25.16 (1.52)
10	EXAMRU	.414	0.28 (6.35)	1.19[b] (2.20)	.56 (1.43)	.22 (3.45)	- .28 (- .56)	- 6.20 (- 2.74)	-2.85 (-1.33)	3.04 (1.07)	-4.44 (-1.12)	-2.76 (-1.40)	-1.68 (- .90)	22.52 (1.86)
11	EXAMAP	.371	0.10 (4.65)	.52[c] (1.84)	.30 (1.65)	.10 (3.35)	.08 (.34)	- 2.70 (- 2.58)	- .87 (- .88)	.85 (.65)	-1.55 (- .85)	1.99 (2.19)	1.31 (1.50)	.23 (.04)

113 Observations

[a]/PRETUC [b]/PRETRU [c]/PRETSA [d]/PRETCA

[e]/Critical t-values for a two-tail test are: 0.1 = 1.66; 0.05 = 1.98; 0.01 = 2.62

[e]/Critical t-values for a one-tail test are: 0.1 = 1.29; 0.05 = 1.66; 0.01 = 2.36

d.F. = 101

Prior economic ability contributes significantly to general achievement in all three models. The signs of the PRETUC variable are positive in the POSTUC and EXAMTT models, indicating the more a student knows about economics at the outset, the more he will know at the end. Again, this is a well-documented result. The negative and highly significant PRETUC coefficient in the gap-closing model is more interesting in that it is inconsistent with Gery's study of alternative cognitive measures (14), but corraborates the negative and significant coefficient in the recent Soper-Thornton study (32). However, the authors believe Soper and Thornton incorrectly attribute their negative PRETUC coefficient to the ceiling effect.

At this juncture it is necessary to clarify the distinction between a 'ceiling' effect and an 'end-hill' effect. The ceiling effect is defined as "bias imposed on test results because of the finite number of questions." (14,p.35) This means that a student with a high pre-TUCE score cannot improve as much in an absolute sense or in a percentage sense, using pre-score as the base. Logically, the high-scoring student has less room for improvement, and this is the ceiling. The gap-closing model, on the other hand, provides all students with the same ceiling, namely, 100% of the potential improvement. Consequently, Soper and Thornton's statement "The higher the original pre-TUCE score due to previous economic knowledge, the lesser the percentage of possible improvement which can be achieved" (32,pp.86-7) is incorrect. Their negative coefficient, as well as ours, confirms not a ceiling effect, but the 'end-hill' effect, where it is more difficult to close a smaller absolute gap than a larger absolute gap because of the difficulty of the items the student encounters.

The maturity variable, AGE, is positive and significant at the 0.1 level in the TUCE models and positive, but not significant in the total exam points model. This is the generally expected sign. More mature students, mature in the academic sense, as well as in chronological age, have been 'through it' and should have a better idea of how the economy operates from news media or other complementary courses, e.g., history and political science. Further, the more mature students should be familiar with more exam-taking tricks.

It is hypothesized that students who are motivated -- turned on by economics -- will perform better on measures of cognitive achievement. Our motivation measure, a post-evaluation of the course, is highly significant in all three models, thus providing reinforcement for Gery's concluding statement "It appears that attitudes and feelings may be just as significant as aptitude and achievement measures in explaining economic understanding " (13, p. 152). At this point a word of caution is appropriate. The hypothesized line of causation is not all that clear to the authors of this paper. Do students do well in economics because they like it, or do they like it because they do well? The actual process could probably best be described by a multi-equation model with some sort of reinforcing feedback loops.

The effort variable, CURCRE, is not significant in any of the models tested. There may be a number of opposing factors contributing to its non-significance, but we have not gathered sufficient data to properly evaluate effort.

Other variables thought to contribute to cognitive achievement were the three student major dummies, SBAM=1, LABM=1, and SSM=1. None of the major variables are significant.

The negative sign and significance of SEXF=1 in all three models is an interesting result.[1] Holding other factors constant, females on the average scored 1.87 points less on the post-TUCE, 8.58 points less in exam points, and 11.25 percentage points less in TUCE gap-closed. One wonders, whether this is due to social and cultural patterns or conditioning within our society, or due strictly to biological differences. It should be noted that if one observes only the difference in means between female and male scores for each of the eleven cognitive achievement variables used in this study, that not one of the differences is significant. The t-values ranged from -0.52 to +0.17. The reason for this appears evident. Seventy-seven percent (23/30) of the females in our sample graduated in the upper 30 per cent of their high school class as opposed to only 37 per cent (31/83) of the males in our sample.[2] So, if high school rank measures general cognitive ability, females of a given cognitive ability do not perform in economics as well as males, but because our classes contained relatively more 'bright' females, the mean differences were not significant.

The instructor variable (INS1=1) is highly significant in both summated TUCE models and not significant in the total exam points model. One explanation is that instructor 1 has historically emphasized application of economic principles in his classes. Since the TUCE is strongly

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[1] This is consistent with other studies-- for example, see (3).

[2] When these percentages were compared with all principles sections during the experimental semester, it was discovered that 63 per cent of 141 females graduated in the top 30% of their high school class as opposed to 37 per cent of 395 males.

application oriented, and since the exams were much less so, this result is not surprising. Further support for this view is suggested by the INS1=1 coefficients in Models 10 and 11 in Table 3.

This illustrates the importance of the instrument used to measure cognitive performance and the need to maintain a degree of independence between the item selection process and the instructors. The exam items-in-common were chosen in a two-step procedure, where instructor 1 selected items from a larger initial set of items determined by the other instructor. The potential for bias is obvious. Ideally, the instructors in a given experiment would list course objectives, indicate sources and material to be covered, and other, independent persons would design and administer the test instrument.

Recognition and Understanding Subpart Models: #s 2, 6, 10; %GCRU, POSTRU, and EXAMRU

Pre-recognition and understanding (PRETRU) was substituted for pre-TUCE as an explanatory variable in all three RU models. Since pre-TUCE was included as a means of controlling for prior economic knowledge, for consistency purposes, the pre-RU score was used to control for prior RU knowledge. In fact, in these models, PRETRU explains more variation in the corresponding dependent variable than did the pre-TUCE.

With one exception, the independent variables significant at the 0.05 level or better were the same for each of the models: HSRANK, PRETRU, EVALTT, and SEXF=1. The instructor variable was found to be significant at the 0.01 level for both TUCE subpart models, and not significant in the total exam points model, thus reinforcing the statements above regarding the need for an independent examining authority.

The 'end-hill' effect was verified for the RU subpart model by the negative and highly significant PRETRU coefficient.

The first maintained cognitive hypothesis, "no loss in the general cognitive abilities of the students in the CAI course," was tested within the %GCRU model by the coefficient of the dummy variable EXP=1. In order to correspond to the procedures of statistical hypothesis testing this maintained hypothesis may be operationally restated as follows:[1]

$$H_O : \beta < 0$$

$$H_A : \beta \geq 0$$

Both the null and alternative hypotheses are composite, with the alternative hypothesis as the maintained hypothesis of the experiment. A critical value of the test statistic (t_c) was determined on the assumption that the population parameter $\beta = 0$.

i.e. $$Pr(\hat{t} > t_c | \beta = 0) = \text{significance level}$$

If the population β is less than zero, and hence consistent with the null hypothesis, the probability of accepting a false alternative hypothesis, having chosen t_c in this manner, would be <u>less than</u> the specified significance level.

In fact the maintained hypothesis does not survive this test. The critical t values for this one-tailed test at the .1, .05, and .01 significance levels are respectively 1.29, 1.66 and 2.36. However, it is noteworthy that given the observed value of the test statistic ($\hat{t}$=1.24), if the population β were less than zero, the probability of observing this t value would be less than 0.11.

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[1] β is the population counterpart of the regression coefficient associated with the dummy variable for experimental treatment.

Simple Application Subpart Models: #s 3, 7, 11; %GCSA, POSTSA, and EXAMAP

Pre-simple application (PRETSA) was substituted for pre-TUCE in all three SA models for the same reason pre-RU was substituted for pre-TUCE above in the RU models. The exam application subpart (EXAMAP) is included in this section because almost all items were classified as simple application.

The set of significant variables in these three models was not as consistent as in the six models already discussed above. First, as before, HSRANK, PRETSA (the prior economic knowledge variable), EVALTT, and INSI=1 (instructor) were all significant at least at the 0.05 level. AGE was significant at least at the 0.1 level in both TUCE SA models, and very close (1.649 -- 1.66) in the EXAMAP model. The science majors, including math, did significantly better on the simple application subpart of the TUCE, indicating, perhaps, some connection between critical thinking and choice of a science major.

The second maintained cognitive hypothesis, "superior ability of CAI students to analyze and think critically about economic issues," was tested within the %GCSA model by the coefficient of EXP=1. This hypothesis is operationally stated as follows:

$$H_0 : \beta \leq 0$$

$$H_A : \beta > 0$$

Once again the maintained hypothesis is the alternative hypothesis. Critical values were determined in the same manner as the first test. However, in this case the assumption of $\beta = 0$ is consistent with the null hypothesis. Furthermore, in this case the observed value of the test statistic ($\hat{t} = 3.52$) dictates rejection of the null hypothesis at the

0.01 significance level. This conclusion was reenforced through the application of the same test to the absolute TUCE model - #7 - which also resulted in rejection at the 0.01 level. In addition, the TUCE backup model, EXAMAP(#11), was significant at the 0.1 level in a one-tailed test.

Complex Application Subpart Models: #s 4 and 8, %GCCA and POSTCA

Pre-complex application was substituted for pre-TUCE in both models. The negative and highly significant PRETCA coefficient confirms the existence of an 'end-hill' effect on this subpart of the TUCE.

HSRANK, EVALTT, and INSI=1 were significant at the 0.01 level in both models. SEXF=1, although significant at the 0.05 level in the gap-closing model, was not significant in the absolute POSTCA model. LABM=1 was negative and significant at the 0.1 level in the POSTCA model, and showed a significant and opposite sign compared to the absolute level model in SA form, thus reenforcing the Lewis-Dahl (21, p. 155) assertion that the TUCE subparts are indeed testing different things.

PART 3. THE AFFECTIVE DOMAIN

The affective domain includes human-learning outcomes "which emphasize a feeling tone, an emotion, or a degree of acceptance or rejection" which may be expressed in terms of "interests, attitudes, appreciations, values, emotional sets, or biases" (18, p. 7).[1]

In this paper, the use of 'attitude' as it relates to the study of economics has been broadened to include commonly used terms such as interest, importance, feelings, disposition, opinions, and mental set.

RESEARCH IN ECONOMICS EDUCATION: THE AFFECTIVE DOMAIN

We believe there are three important reasons for investigating student attitudes in economics. First, in the Mann-Fusfeld sense (22), we feel that educating the whole person involves favorable changes in both cognitive and attitudinal domains. Therefore, an evaluation of

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[1] The major process of the affective domain, sometimes called 'internalization' is the "continuous modification of behavior from the individual's being aware of a phenomenon to a pervasive outlook on life that influences all his actions" (18, p. 33). The affective domain can be viewed as five-level hierarchy of types of affective human learning outcomes including: 1. receiving (awareness and willingness); 2. responding (acquiescence, willingness, and satisfaction); 3. valuing (acceptance, preference, and commitment); 4. organization (conceptualization organization of a value system); and 5. characterization by a general value complex.

Interest in and perceived importance of a subject area generally describe behavior that would be classified at the lower levels of the taxonomy. Bloom, et. al, use the term 'attitude' to describe the degree of involvement of the student ranging from one who is willing to grant that he has a positive (or negative) feeling about something to one who goes out of his way to express himself and communicate with others. (18, p. 25) 'Attitudes' and 'values' are used to describe the same thing.

any instructional process must investigate the impact of the process on affective, as well as cognitive output.

Second, there may be interaction between certain attitudinal components and cognitive achievement. Given a specific instructional treatment, students with certain attitudinal patterns may learn more than others.

Third, certain attitudinal components may be used as proxies for the degree of long-term cognitive retention. The Emery-Schoene study reviewed by Soper (29) supports the hypothesis that an index of student interest and importance regarding economics may be a significant variable in explaining retention. If this is true, by assessing affective achievement, we are simultaneously assessing both the short and long-term implications of any given instructional process or technology.

Attitudinal Measurement in Economics

One of the basic criticisms of the affective domain literature is the lack of comparability from one study to the next. A Likert-type or semantic differential instrument is usually administered (pre,post, or both) and several related or unrelated affective domain components are frequently compressed into a single variable called "attitude". One author's interpretation of attitude need not, and indeed, probably will not, coincide with anyone else's.

The authors' review of the economics literature leads us to place student attitudinal components in four major categories:

1. Interest in economics
2. Importance of economics
3. Attitudes toward the instructional process
4. Attitudes regarding specific issues in economics

McConnell's eleven item attitudinal instrument has been used in several published studies; e.g., (23,24). It contains an instructional process category and a mixed collection of items called "attitude toward discipline". The latter apparently focuses on importance, but also contains several instructional process items, as well as several items which may be construed to measure both importance and interest.

Karstensson developed and, on a limited basis, tested an "attitude toward economics" instrument which contains items regarding interest, importance, and intention to take more economics courses in the future (16,17). It was used to develop only a single unweighted index. This instrument, as well as McConnell's, contains the item "do you plan to enroll in more economics courses" which reflects attitudes to a certain degree, but which automatically biases responses of those students who are required to take additional coursework in economics.

Sloane, on the other hand, explicitly recognized different dimensions of attitude (28). He considered three separate attitudinal categories which coincide with the first three contained in this study. Interest in economics and importance of economics were each measured with a single item. Attitudes regarding the instructional process, measured by the Illinois CEQ (1), were broken down into five additional categories; method of instruction, course content and materials, general course attitude, instructor, and interest in the course.

Numerous other studies, each with a unique emphasis, focus on attitudes which fit into the fourth category. Representative attitude indices include Mann and Fusfeld's "attitude sophistication" (22) and Scott and Rothman's "liberal-conservative" measure of student political attitudes (27).

Other studies (e.g., 35) have used factor analysis, a multivariate technique which employs the data set itself to determine factors or attitudinal categories. Factor analysis is frequently used to circumvent multicollinearity caused by overlapping of attitudinal components and the 'halo' effect. Several of the standard criticisms can be applied to the use of factor analysis in this situation such as the problem of factor interpretation and the arbitrary nature of determining factor loading cut-off points.

In summary, the above review indicates a need for a uniform, nationally validated and normed affective domain instrument like the TUCE, which can be broken down into subscales to test various attitudinal components of alternative instructional methods. The literature indicates an increasing awareness of affective components in economic education, and, now, because of the profession's increased sophistication and experience using the TUCE, the time has come for such an instrument.

Variable Placement in the Model

The economic education literature contains many examples of affective domain research. Student attitudes have been used in a number of different ways in both implicit and explicit models of student performance. Some studies consider the various attitude components as independent variables, some as dependent variables, some as both, and many without any intuitive or theoretical justification.

First consider the use of attitude, however defined, as an independent variable. Some researchers have hypothesized a causal relationship between an initial attitudinal component and cognitive achievement. The presumption is if students have a "good" attitude toward economics at the beginning of the course, then their cognitive performance will be better, ceteris paribus, as a result of the instructional process.[1]

Second, consider the use of attitude as a dependent variable. Some authors not only visualize attitudinal variables as emerging from a course but, like cognitive achievement, view them as being measurable and explained by the instructional process and other independent variables.[2]

In this study student attitudes were considered in both ways, but in separate contexts. Recall that in investigating cognitive achievement, certain student attitudes were viewed as playing an explanatory role. We will now consider post course attitudes toward economics -- interest, importance and specific issues -- as outputs of the instructional process and as such regard them as dependent variables. We believe that attitudes are determined by the instructional process as well as certain other variables. Among these other variables are the student's perception of reality and destiny, personal characteristics, training, and environmental factors (social, cultural, economic, and intellectual).

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[1]Published studies which incorporate models of this type include 17, 20, 23, 28 and 35.

[2]Published studies which incorporate models of this type include 20, 23, 27 and 35.

The Dependent Variable and Affective Performance

Attitude, however measured, when used as a dependent variable, is usually found in one of two forms. Often the 'absolute' model is used, where post attitude is the dependent variable and pre attitude is an independent variable. Frequently the 'gap' model is used, where (post minus pre) is used as the dependent variable. A variation of the 'gap' model also incorporates pre-attitude as an independent variable.

In linear form, the two models are observationally equivalent; all coefficent estimates will be the same, with the exception of the pre attitude coefficient and its standard error. The coefficient in the 'gap' model will be (1-b), where b is the pre attitude coefficient in the 'absolute' model. All corresponding t values will be the same in both models.

Other measures of attitudinal performance have generally not been considered. For example, the Gery 'gap-closing' model, which is frequently used to assess performance in the cognitive domain, is not appropriate for measuring attitudinal change because pre attitude may not be a meaningful floor. The tacit assumption in this model is that of an improvement from pre to post; i.e., there is a gap and it is being closed. Evidence suggests this is valid when applied to cognitive performance. However, it is not clear a priori that students will experience only a positive change in attitude as a result of the instructional process. Indeed, evidence suggests a negative change in attitude may be the norm (16).

The Independent Variables

Little attention has been devoted to the construction of a structural model of affective performance in economics. For the most part, regression models which feature an attitudinal dependent variable have been employed in attempts to assess the impact of different instructional strategies. In general, these models use the same independent variable set as those used in assessing cognitive achievement.

This type of modeling can be illustrated by the Paden-Moyer (26) study which employed two regression models to statistically control for non-experimental factors while investigating the impact of televised lectures on cognitive and affective outputs. The basic forms of these models were:

(1) Cognitive Performance = f(A, C, EXP)

(2) Affective Performance = f(C, EXP)

where A is an attitude variable, C represents a common set of control variables, and EXP is the experimental 0-1 dummy.

The control variables for their cognitive achievement model involved six categories: general cognitive ability, prior economic knowledge, maturity, motivation, effort and other. Their affective model employed the same set of control variables, with the obvious exception of the motivation variables. In general, the control variables used in other attitudinal studies can be placed in the same six categories, e.g., (20), (28), (35).

The joint use of a control variable set in both regression models can be supported on logical grounds. Since this study considers both affective and cognitive outputs as resultants of the instructional

process, it seems reasonable to visualize these outputs as being produced by the same instructional process which, in turn, is conditioned by a similar set of student characteristics.

The Integrated Model of Affective Performance

The affective performance model assumes the same general form as the cognitive performance model:

$$AP = f(SC, IP)$$

where

AP = Affective Performance

SC = Student Characteristics

IP = Instructional Process

Of the four attitudinal dimensions previously mentioned, three were selected as dependent variables; namely, interest in economics, importance of economics, and attitudes toward specific economic issues.

While the set of control variables used in the affective model is similar to the set employed in the cognitive model, it differs primarily in the area of SC. The IP variables were retained in their entirety and treated in exactly the same manner as in the cognitive model. Student characteristics, on the other hand, were grouped in four distinct categories and one residual category:

1. Prior Economic Knowledge
2. Maturity
3. Perception of the Instructional Process
4. Peer Group Dissonance
5. Other (sex and major)

In the cognitive model six categories were identified compared with only five for the affective model. Three categories (prior economic knowledge, maturity and other) are common to both models, and as such, retain the same interpretation. Student perception of the instructional process is multi-dimensional involving attitudes toward the method of instruction, course content, and the instructor.

While the four categories mentioned above involved relatively simple interpretation, the peer group dissonance category is more complex. Dissonance refers to "any lack of harmony or agreement". It was felt that each student enters a course with an environmentally conditioned expectation of a given performance on examinations relative to his peers. Dissonance, in the sense described here, focuses on the incongruity between expected and actual performance. Students who do not achieve their expected performance levels will tend to develop an unfavorable attitude posture toward the subject matter in question.

STATISTICAL RESULTS

Selection of the Dependent Variables

Student attitudes were surveyed at the beginning and at the end of the semester. The same 20 item attitude instrument was administered as a pre-test and a post-test.[1] The items were drawn from the two sources discussed previously. The first 10 items were adapted from the

[1]The attitude survey is presented in Appendix B.

Mann-Fusfeld "attitude sophistication" study (22). Each item is a statement about some economic issue discussed during the semester. Students in the experiment registered the strength of their agreement or disagreement on a five point scale. A five represented a "sophisticated" response, in the authors' judgment, and a one an unsophisticated response.

The remaining items in the attitude survey, eleven through twenty, duplicated in total the ten item Karstensson questionnaire of student attitudes toward economics (16, 17). Each of these items measures some attitudinal dimension on a one to five scale, where one is least favorable.

Three dependent variables were derived from the instrument by summing the values for subsets of items corresponding to three attitudinal components. The first is related to specific issues in economics. The proxy for this component is the sum of the attitude sophistication items. Specifically, POSSOP, the first dependent variable, is the "score" of the first ten items on the post-attitude survey. The potential range for POSSOP is ten to fifty, where a score of fifty represents the most sophisticated responses.

The second dependent variable focuses on student interest in the study of economics. The proxy for interest is the sum of responses to items #11, #15, and #16 on the post-attitude survey. The possible range for POSINT is three to fifteen, where fifteen is the most favorable attitude.

The third dependent variable viewed student attitude toward the importance of economics. The proxy for importance is the sum of

responses to items #12, #14, and #19 on the post attitude survey. The possible range for POSIMP is the same as above, where fifteen is the most favorable attitude.

To summarize: three measures were arbitrarily defined to serve as proxies for three of the attitudinal components described in the previous section. These are, respectively, POSSOP, attitude toward specific issues in economics; POSINT, interest in economics; and POSIMP, attitude toward the importance of economics. These three measures served as the dependent variables in the models presented below.

The originally maintained affective hypothesis:

> In relation to the traditional principles course, the experimental CAI course will result in more favorable attitudes toward economics.

may be restated with an emphasis on attitudinal components:

> In relation to the traditional principles course, the experimental course will result in:
>
> 1. A more sophisticated attitude toward specified issues in economics;
> 2. a greater interest in the study of economics; and
> 3. a more favorable attitude toward the importance of economics.

Each of these hypotheses were tested within the multiple regression framework described in Part 1. The dependent variables for each model designed to test the three stated hypotheses were respectively, POSSOP, POSINT, and POSIMP. The integrated model presented in the previous section outlines five theoretical categories of factors thought to contribute to affective achievement and which must be controlled in order to assess the independent effect of CAI.

Selection of the Independent Variable Set

The selection and use of operational proxies for the integrated affective model categories involved the customary problems of multicollinearity and the absence or unavailability certain critical data. Moreover, restrictive assumptions were required in the construction of the proxies, since direct measurement was not possible in all cases.

All three of the affective hypotheses were tested with the "standard set" of independent variables which were selected and constructed within the categories outlined in the previous section. A discussion of variables by category follows.

Prior Economic Knowledge

Two measures of prior economic knowledge were considered: high school economics and pre-TUCE score (PRETUC). The former was rejected on the basis of information reported in the description of the cognitive performance model. The latter was retained as the measure of prior economic knowledge because it was believed that any effect of economics on attitudes would be transmitted through the PRETUC score.

Maturity

The development of a proxy for maturity followed the procedure established in the cognitive achievement model. Chronological AGE was chosen.

Perception of the Instructional Process

Perception of the instructional process is multidimensional and involves such things as attitudes toward the instructor and course content.

A post-course evaluation instrument consisting of 25 items was used as the basis for the construction of EVALTT, a simple unweighted summated score of all items.[1] The potential scale range was 25 to 101, where 101 represents the most favorable perception of the instructional process.

It should be noted that EVALTT also appears in the cognitive achievement model as a proxy for motivation. This is not inconsistent with its use here. For example, a favorable view of the instructional process can motivate students to greater cognitive achievement, while at the same time have an impact on the various attitudinal components.

Peer Group Dissonance

Dissonance, in the sense described previously, focuses on the incongruity between a student's expected performance in the class and the student's actual performance. Since no direct measure of dissonance was available, a measure was constructed on the basis of two assumptions:

1. Initially each student has a general feeling for how he will perform in any given class relative to others, on the basis of previous experience.

2. By the end of the semester, after seeing the results of three exams, each student is capable of making an accurate prediction regarding his final grade.

With respect to the first assumption, high school rank, in percentile form, was thought to serve as an indicator of previous

[1] All but one of the items were drawn from the Illinois Course Evaluation Questionnaire (1). The last item was required by University Administration for instructor evaluation purposes. The questionnaire is presented in Appendix B.

experience. With respect to the second, rank in class based on exam performance (in percentile form) served as an indicator of expected final grade. Peer group dissonance was then indirectly measured through the variable DISSON which is the difference between high school percentile rank and exam percentile rank. For example a student who ranked in the top 10% of his high school class (i.e., 90th percentile) and who was doing poorly in economics (e.g., 30th percentile), would have a high degree of dissonance -- DISSON = 90 - 30 = 60. On the other hand, a student who did not do well in high school, but was doing very well in economics would have a low, or even negative, value for DISSON.

Other

Several other variables mentioned in the literature and thought in some instances to influence affective performance were included. These variables include a sex dummy (SEX=1) and three university major (0-1) classification dummies, School of Business Administration (SBAM=1), lab science - include math - (LABM=1), and social science (SSM=1). All four variables were also included in the model of cognitive performance.

Three additional variables were included in the affective achievement models. Initial attitudes were controlled in each model. The premeasure included for each dependent variable were: PRESOP for POSSOP, PREINT for POSINT, and PREIMP for POSIMP.

Simple Tests of Difference between Means

Table 4 contains experiment and control means, mean differences, and t-tests for the "standard set" of independent variables used in the subsequent regression analysis. Although the distribution, as well as the mean, of each variable may have some impact on the dependent variable, the table indicates very few differences between experimental and control

TABLE 4 Simple tests of Difference Between Control and Experiment Section Means for Independent Variables Included in the Affective Performance Models

Variable	Means		Difference (Exp-Con)	t*
	Experiment	Control		
PRETUC	11.21	11.04	.17	.27
AGE	19.57	19.44	.13	.27
EVALTT	68.77	68.51	.26	.09
DISSON	14.65	14.76	-.11	-.02
SEXF=1	.25	.28	-.03	-.37
SBAM=1	.34	.46	-.14	-1.27
LABM=1	.16	.12	-.04	-.57
SSM=1	.09	.05	.04	.75
PRESOP	32.52	33.67	-1.05	-1.62
PREINT	11.80	11.53	.27	.79
PREIMP	12.48	12.40	.08	.27

*Critical t values (d.F.=111) for a two-tail test of no difference are:

Significance Level	Critical t
0.1	1.66
0.05	1.98
0.01	2.62

groups. The t-value showing the greatest deviation from zero is associated with pre-sophistication, or PRESOP. Even so, the mean PRESOP difference between experiment and control sections was not statistically significant at the .05 level.

Table 5 displays the mean difference between the experimental and control sections and the simple t-test of that difference for each dependent variable. The null hypothesis of no difference cannot be rejected on the basis of these tests. Although tests of mean difference are not significant, it is noteworthy that a high PRESOP score for the control sections (see Table 4) persisted and no doubt contributed to the high POSSOP scores evident in Table 5.

Since both experimental and control student group characteristics appear to be similar, the mean difference tests should be and are, similar to the full model tests below. However, proper methodology dictates that full regression model tests be pursued. Group means may hide individual differences that when properly matched have a significant impact on experimental conclusions.

Regression Models

Table 6 contains the parameter estimates and summary statistics for the three affective performance models. These models served to test the restated hypotheses relating to the impact of CAI on the various attitudinal components.

TABLE 5 Simple Tests of Difference Between Control and Experimental Section Measures of Affective Performance

Variable	Means		Difference (Exp-Con)	t*
	Experiment	Control		
POSSOP	34.18	35.26	-1.08	-1.65
POSINT	10.77	10.54	.23	.39
POSIMP	12.16	11.89	.27	.59

*Critical t-values are equivalent to those for Table 4.

TABLE 6

AFFECTIVE PERFORMANCE MODELS

(t-values in parentheses)[a]

Dependent Variables	Adjusted R^2	Independent Variables													Constant Term
		PREINT	PREIMP	PRESOP	DISSON	PRETUC	AGE	EVALTT	SEXF=1	SBAM=1	LABM=1	SSM=1	INSI=1	EXP=1	
POSINT	.57	.56 (5.17)	--	--	- .20 (-2.64)	.14 (2.37)	.01 (0.08)	.08 (5.72)	- .32 (-0.70)	1.54 (3.46)	1.17 (1.99)	- .01 (-0.02)	.26 (0.32)	.12 (0.32)	-3.65 (-1.69)
POSIMP	.57	--	.43 (4.20)	--	- .01 (-0.75)	.06 (1.39)	- .08 (-1.28)	.09 (7.58)	.17 (0.46)	.81 (2.32)	.54 (1.16)	- .98 (-1.56)	- .38 (-1.19)	.36 (1.20)	1.30 (0.71)
POSSOP	.13	--	--	.29 (3.38)	- .03 (-2.33)	.19 (2.03)	- .06 (-0.43)	- .03 (-1.29)	.53 (0.70)	.28 (0.38)	- .05 (-0.05)	1.10 (0.85)	- .38 (-0.57)	- .72 (-1.14)	.27 (6.26

113 Observations

[a/] Critical t-values for a two-tail test are: 0.1 = 1.66; 0.05 = 1.98; 0.01 = 2.62

[a]/Critical t-values for a one-tail test are: 0.1 = 1.29; 0.05 = 1.66; 0.01 = 2.36

d.F. = 101

The adjusted R^2 for both the POSINT and POSIMP models is .57, while the R^2 for the third model, POSSOP is only .13. Clearly, the models explain more of the variation in attitudes regarding interest and importance than what is referred to as attitude sophistication. Interest and importance are pure attitudinal components, while - "attitude sophistication" contains a cognitive component.

All three models exhibit positive and highly significant pre-measures (PREINT, PREIMP, and PRESOP). This indicates that attitudes tend to persist or change slowly. Students who enter a principles course with favorable attitudes toward economics tend to emerge from the instructional process with the same favorable views.

The dissonance variable, DISSON, carries a negative sign in all three models and is significant in POSINT and POSSOP. This means that the greater the gap between the student's expected performance and his actual performance, the less interested the student is in studying more economics and the less sophisticated his understanding of economic issues. However, a high level of dissonance is not significantly related to attitudes regarding the importance of economics. Students evidently can lose interest in the study of economics, but still think it is important!

Previous economics knowledge has a positive influence on attitudes toward economics. Students who do well on the pre-TUCE(PRETUC) tend to have a greater interest in studying economics and a greater degree of attitude sophistication. However, the statistical analysis presented here cannot aid in unraveling the threads of influence. The question posed in an earlier section remains: Do students do well in economics because they are interested, or are students interested in economics because they do well?

The maturity variable, AGE, is not related to the dependent variable in any of the affective performance models. This is in contrast to the impact of AGE on cognitive performance where age was found to be directly related to cognitive achievement. This lends additional support to the notion that attitudes persist or only change slowly. Older students, while they "learn" more, do not experience an equivalent improvement in attitudes.

The sex variable presents the most interesting contrast of all. SEXF=1 is not significant in any of the affective models. This means that the sex of the student ceteris paribus, plays no apparent role in the determination of attitudes toward economics. This differs sharply from the well-documented negative and significant coefficients observed in cognitive models. This means that females do not do as well as males in economics classes, but they do not enjoy it less!

There are three significant coefficients among the "major" variables. School of Business majors tend to believe economics is both interesting and important. But they were no more (or less) 'sophisticated' that others in their understanding of economic issues. The science majors were significantly more interested in economics, but, as Table 6 indicates, they were neither more sophisticated in their understanding of economic issues nor did they think economics was more important than the other students. Perhaps the science majors' interest in the study of economics is related to the economists' application of analytical techniques and their affinity for the same.

Finally, none of the instructor coefficients (INSI=1) is significant. This means that neither of the two instructors in the experiment resulted in significantly influencing student attitudes to a greater degree than the other.

The maintained affective hypothesis "CAI will result in more favorable attitudes toward economics" is tested for three attitudinal components by the coefficient of the dummy variable EXP=1. The restated hypothesis is subject to a test of the form:

$$H_0: \beta \leq 0$$

$$H_A: \beta > 0$$

On the basis of the coefficients presented in Table 6, we cannot reject the null hypothesis. Accordingly, the experimental course did not result in a more sophisticated attitude toward economic issues, a greater interest in the study of economics, or a more favorable attitude toward economics.

PART 4. SUMMARY AND CONCLUSIONS

The primary objective of this study was the evaluation of an integrated set of CAI materials. Therefore, in reviewing the results and stating our conclusions we will consider evaluation first. However, the evaluation is closely related to structural considerations. Simply put, in order to control those factors other than experimental treatment which determine cognitive and affective performance, we must first identify them. From a broader point of view, a structural model of the integrated learning and attitude modification process is called for. Such a model would involve a multiple equation system from which legitimate reduced form equations for cognitive and affective performance could be determined. We did not attempt to build such a model. Our linear, single equation structures for cognitive and affective performance were separately developed largely on the basis of information in the literature of economic education. However, there are a few places where interesting structural results were produced. Consequently, these novel structural outcomes will also be presented.

This part is divided into three sections. In the first section, results pertaining to the cognitive domain (Part 2) are summarized. The second section reviews affective domain (Part 3) results. Finally, the last section discusses some general considerations that bear on the interpretation of results.

COGNITIVE DOMAIN

Exposure to our CAI materials appears to give no significant advantage on overall cognitive performance. Examination of variables measuring percentage gap-closed on the TUCE, post TUCE score, and score

on common exam questions, indicates that the experimental group did neither better nor worse. This was the case on the basis of both tests of mean difference and multiple regression models. However, examination of specific types of cognitive performance in relation to the maintained hypotheses of the experiment produced somewhat different results.

Our first maintained cognitive hypothesis was that students given the opportunity to employ the CAI materials would suffer no loss in lower level cognitive capability with respect to the principles of macroeconomics, when they were compared with students not given such opportunity. This hypothesis was tested on the basis of performance on the recognition and understanding subpart of the TUCE. In particular, the key variable was percentage gap-closed from the pre to the post test on these recognition and understanding questions. For this variable a test of mean difference between the experimental and control groups was not statistically significant. However, a test focusing on the coefficient of an experimental treatment dummy variable in a multiple regression model did not support this maintained hypothesis. A null hypothesis of loss could not be rejected at the 0.1 significance level using a one-tailed test.

Our second maintained cognitive hypothesis was that students given the opportunity to employ the CAI materials would develop superior analytical ability with respect to macroeconomic principles, when they were compared with students not given such an opportunity. This hypothesis was tested on the basis of performance on the simple application subpart of the TUCE. Once again the key variable was the percentage of pre to post gap-closed. A t test of

mean difference between the experimental and control groups was statistically significant. Furthermore, a variety of regression results supported this hypothesis. A null hypothesis of no performance gain was rejected in the gap-closing and post TUCE models at the 0.01 significance level and rejected in the common exam question model at the 0.1 level using a one tail test.

To put these cognitive results in perspective they should be compared with reported evaluation results for other integrated CAI materials in the principles of macroeconomics. At Arizona State, Steven Cox has developed, employed and evaluated a set of eight macro simulations and two games (8). All the materials were used in batch mode. At Illinois State, Chizmar, Hiebert and McCarney (6) employed and evaluated a system of 31 instructional programs that were developed at Notre Dame by Bonello, Davisson and Jameson (10). In this system there are three types of interactive programs; reviews, demonstrations and simulations. A review is essentially a multiple choice quiz, while the simulations and demonstrations are respectively more and less sophisticated simulations.

The Cox materials were evaluated in the context of a formal experimental design, while the Chizmar, Hiebert and McCarney evaluation of the Notre Dame materials was based on optional student use in a standard large lecture macro principles course. The data base generated in each evaluation was analyzed on the basis of multiple regression models similar to the cognitive models employed in this study. However, the Chizmar et. al. data base did not include information on the affective domain. The cognitive instrument employed by Cox was composed of 10 simple and 20 complex application questions selected from the TUCE.

Chizmar et. al. employed the entire post TUCE. Cox found that the coefficient associated with a dummy variable representing experimental treatment was not statistically significant. Chizmar et. al. found that the coefficient associated with a dummy variable coded one if a student used at least one CAI program was not statistically significant. Furthermore, when this dummy was replaced by a variable measuring the intensity of CAI use, the coefficient associated with this variable was negative and statistically significant at the 0.068 level.[1]

Structurally the most interesting cognitive outcome was what we have termed the end-hill effect. This effect is displayed in the context of a gap-closing model. Essentially it means that, ceteris paribus, there is an inverse relation between pre TUCE score and the percentage gap closed. The effect is induced by the dispersion of item difficulty on the TUCE. Clearly it is tautological to say that those items the student of average ability answers correctly will have a higher average difficulty

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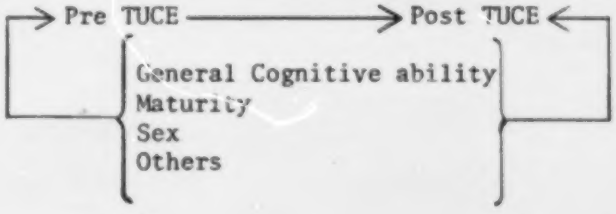
[1]It is noteworthy that our results with an intensity of use variable are not in accord with those of Chizmar et. al. For the sake of comparability, all control section observations were deleted from the data base -- leaving a sample of size 56. To eliminate the effects of multicollinearity the instructor dummy (INS1=1) was deleted from these observations. With these alterations the summated TUCE models (Table 3 - Models 1 and 5) were reestimated with a variable measuring hours of CAI usage replacing the experimental treatment dummy. The coefficient associated with this variable is positive and statistically significant at the 0.05 level for the gap-closing model (Model 1) and at the 0.01 level for the post TUCE model (Model 5). Similarly, after eliminating the control observations, the coefficient associated with this intensity variable was positive and significant at the 0.01 level for the exam questions in common model (Table 3 and Model 9). These results were not reported in the main body of the study because in general the use of this type of treatment variable is not compatible with our experimental design.

index than those he answers incorrectly. From this it follows that as one considers students with greater ability -- i.e., more questions answered correctly -- the average difficulty index of questions incorrectly answered would tend to decrease. The relatively easier questions will be answered correctly first. Consequently, the higher the absolute pre TUCE score attained by a student, the smaller the percentage of the 33 minus Pre TUCE score gap that will be closed on the post TUCE because of the increasing difficulty of the questions encountered. The moral here is that when one uses a pre-measure to allow for "starting gate" difference, and a gap-closing model to compensate for a "ceiling effect", one should not be surprised if an end-hill is evident.

A second structural characteristic has to do with the use of an instrumental variable estimation technique first employed in economic education research by Soper and Thornton. In our review of the cognitive literature contained in Part 2, it was pointed out that several authors made a distinction between the variables determining pre TUCE score and those determining post TUCE. The general idea is that pre TUCE score should be viewed as endogenously determined by certain variables which also have a direct impact on post TUCE scores. Soper and Thornton (32) hypothesize that pre TUCE is a function of general cognitive ability, maturity, and sex; and that these same variables and others also have a direct impact on post TUCE.



Therefore, if pre-TUCE score enters as an independent variable, along with these others, in a multiple regression with post-TUCE score as the dependent variable, the resulting estimates will be subject to problems resulting from multicollinearity and specification error. The former will inflate the standard error associated with coefficient estimates on collinear variables, and the latter will affect the size of the coefficients themselves.[1]

In order to avoid these difficulties, Soper and Thornton proposed a two step estimation procedure. The first step is to regress pre-TUCE scores on variables measuring general cognitive ability, maturity and sex. The second step is to use the regression residuals from the first step as a proxy variable for pre-TUCE in a regression equation with post-TUCE as the dependent variable. This procedure essentially eliminates the effect of the three variables on pre TUCE and leaves the remaining variation in pre TUCE, in the form of the proxy variable, to explain variation in post TUCE. This approach has been used successfully by Soper and Thornton (32); Soper (30); and Chizmar, Hiebert and McCarney (6).

In order to see whether the results of these studies could be replicated with our data base, a proxy for PRETUC was constructed on the basis of

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[1] These problems will only effect the coefficients of the variables determining pre TUCE. In particular, there will be no effect on the coefficient (or its standard error) of an independent dummy variable representing experimental treatment. Therefore, as with this study, if the primary objective is evaluation, special estimation techniques to avoid these problems would not necessarily have to be employed.

HSRANK, AGE and SEXF=1. When this proxy variable was employed in place of PRETUC in the post-TUCE regression model (Table 3 - Model 5), the t ratios for HSRANK, AGE and SEXF=1 all increased.[1] This is consistent with the results of the three cited studies. The t ratios increase because the procedure reduces multicollinearity and hence estimated standard error of the regression coefficients, and it reduces specification error and thus increases the size of the coefficient.

In view of the acknowledged impact of attitudes on cognitive performance, it is significant that all three of the studies ignored the affective domain. In employing the estimation procedures used in these studies, the presence of affective domain information in our data base produced interesting results. In conjunction with the two-stage estimation procedure, Soper and Thornton have advocated the use of the Farrar-Glauber procedure to detect multicollinearity (12). Use of this procedure on our independent variable set for the post-TUCE regression model indicated that pre-TUCE was also collinear with the post-course motivation measure (EVALTT).

As previously indicated (see p. 10) Lewis and Dahl (20) hypothesized that pre-course motivation would have a direct effect on pre-TUCE score. From this point of view, the observed connection between PRETUC and EVALTT could have been indirectly induced by a strong correlation between a pre-motivation measure and EVALTT.

Since our data base contained no pre-measure corresponding precisely to EVALTT, for the sake of consistency the post-TUCE regression model was reestimated with POSATT substituted for EVALTT.[2] Because of the close

[1] However, it is somewhat perplexing that when the proxy is substituted into the gap-closing model (Table 3 - Model 1) these t ratios all decrease.

[2] For a discussion of the motivation measures and their interrelationships see p. 20.

association between EVALTT and POSATT this substitution had little effect on the goodness of fit of the equation or on the significance of any of the variables. Furthermore, the Farrar-Glauber procedure continued to indicate collinearity between PRETUC and the post-course motivation measure -- in this case POSATT.

A proxy for PRETUC was constructed on the basis of HSRANK, AGE, SEXF=1 and the pre-motivation measure PREATT. It was found that PREATT contributed virtually nothing to an explanation of PRETUC variance, and when the proxy was substituted for PRETUC in the reestimated Model 5, collinearity between the proxy and POSATT was evident. The partial correlation coefficient between the two, tested in a Farrar-Glauber procedure, was positive and statistically significant at the 0.01 level.

Clearly it does not make temporal sense to hypothesize that a post course motivation measure has a direct causal effect on a pre course cognitive performance measure. However, these results are consistent with the hypothesis that the causality runs in the other direction. That is, prior knowledge of economics has a direct impact on attitudes toward the subject matter of economics and the instructional process. This is the position taken in the affective performance Model of Part 3.

This result not only illustrates the interaction between the cognitive and affective domains, but has definite implications for valid statistical procedures. If one's goal is unbiased structural estimation, then this calls for a model in which both cognitive and affective performance are endogenous and simultaneously determined. Ordinary least squares applied to an equation such as Model 5, or for that matter any of the cognitive regression models containing a post motivation measure, must be subject

to simultaneous equation bias. On the other hand, to ignore the affective domain, as did Soper-Thornton (32), Soper (30), and Chizmar et. al. (6); is to invite specification bias.

AFFECTIVE DOMAIN

For most students, using the computer in an instructional context is a new experience. If CAI materials requiring an active student role are carefully constructed for subject matter amenable to the computer, these materials should have a favorable impact on student attitudes. With these considerations in mind, the impact of experimental treatment on three separate attitudinal components was examined.

With respect to (1) attitude sophistication, our maintained hypothesis was that students given the opportunity to employ the CAI materials would display a more sophisticated attitude toward specific economic issues, when they were compared with students not given such an opportunity. Post course attitude sophistication was measured in terms of the variable POSSOP -- the score on ten attitude sophistication items included in a post attitude survey. For this variable a t test of mean difference between the experimental and control groups was not statistically significant. Furthermore, in a regression model a t test on the coefficient of a dummy variable representing experimental treatment indicated a lack of statistical significance.

The same results were evident with respect to the attitudinal components (2) interest in economics and (3) importance of economics. The former was measured on the post attitude survey in terms of three items drawn from the Karstensson questionnaire. The latter was measured in a similar manner. Both tests of mean difference and regression related tests indicated a lack of statistical significance.

The only reported results to which these may be compared are those of Cox (8). Cox did not construct a model of affective performance, his primary concern was cognitive output. However, he felt that cognitive performance was significantly influenced by interest and motivation. In an attempt to measure these variables Cox administered pre and post course surveys containing items related to these concepts. From survey responses Cox constructed separate indices of interest and motivation. In turn, these indices were used as independent variables in a regression equation with a measure of cognitive performance as the dependent variable. In addition to his cognitive results, Cox also reported that mean difference between the experimental and control groups for both the interest and motivation indices was not significantly different from zero at the 0.1 level.

In a structural sense the most interesting outcome of our affective estimation was the significance of the peer group dissonance variable (DISSON) in the regression models for interest in economics (POSINT) and attitude sophistication (POSSOF). The construction and use of this variable was motivated by the personal experience of the authors and the on-going debate concerning the student evaluation of teaching.[1] In particular there is a widespread and controversial belief that a student's actual or expected grade influences his evaluation of an instructor. Presumably, a halo effect carries this relationship over to the students' attitudes toward the instructional process in general and course subject matter. Soper (31) has conjectured that a significant relationship exists between the student

[1] The Fall, 1973 issue of the Journal of Economic Education is devoted to this issue.

evaluation of teaching and a variable measuring the deviation of expected grade from "target" grade. Pursuing this line of reasoning, student determination of a target grade must be related to the students' perception of where he should stand in relation to peers. In which case it is reasonable to conclude that a variable measuring a gap of the type found in DISSON would have an effect on affective output.

A second significant structural outcome concerns the interaction between the cognitive and affective domains discussed in the cognitive summary. The connection between prior economic knowledge and post course attitudes is evident in the regression models for POSINT and POSSOP. In both cases the pre TUCE score is positive and statistically significant at the 0.05 level.

CONCLUSION

The data indicate that exposure to our integrated CAI materials has a significant positive effect on basic analytical ability not displayed or reported for other comparable materials. However, this does not appear to be strong enough to produce significant results across all question types on a general cognitive instrument. Furthermore, the affective results clearly indicate no effect.

In attempting to account for these results a number of factors need to be cited. CAI materials are not uniform in type or quality. It is possible that the combination of tutorial drill and gaming in our materials develops an ability to answer basic analytic questions. There is fragmentary evidence in the literature that supports this. Emery and Enger (11) found that a fiscal policy game, similar to a game contained in our materials,

produced significant improvement in performance on simple and complex analysis questions related to fiscal policy. Similarly, the gaming experience had no significant impact on recognition and understanding questions.

Furthermore, it is noteworthy that our experiment was based on optional use of the CAI materials. In view of differences in student preferences, the authors did not attempt to compel a student to employ a particular mode of learning. As a result there were students in the experimental sections who never logged in on the computer, and among those who did, the extent of usage varied widely.

On the negative side, our data base is relatively small. We have only 113 observations on which to base our conclusions. Compared to many evaluation studies in economic education, especially at very large institutions, this is not a large sample. As an example of the problems that may result, consider Table 2. Note that the control sections mean for gap closed on simple application questions is slightly larger than 6%. Inspection of our historical data over several years at UW-L indicates that the section average for this variable is close to 16% with a lower bound of around 5%.

Finally the authors are well aware that they are evaluating their own materials. Clearly, evaluation by other instructors, perhaps even at a different institution, would be desirable.

APPENDIX A.

VARIABLE DEFINITIONS AND ABBREVIATIONS

VARIABLE DEFINITIONS AND ABBREVIATIONS

(Student Characteristics)

AGE
Chronological age in years

CURCRE
Current semester credit hour load

HSEC=1
High School Economics -0 = No, 1 = Yes

HSRANK
High School Rank in Percentile

HSSIZE
High School Size (Categorical variable: 7 classes)

LABM=1
Science major=1
(Includes: Biology, Chemistry, Physics, Math)
Non-Science major=0

MARR=1
Married - 0=No, 1=Yes

SBAM=1
School of Business Administration major=1
Non School of Business Administration major=0

SEXF=1
Sex = 0-Male, 1=Female

SSM=1
Social Studies major=1
(Includes: Psychology, Sociology, Anthropology, Geography, Political Science)
Non-Social Studies major=0

TOTCRE
Total College Credits earned not including CURCRE

(Instructional Process)

EXP=1
Experimental treatment - Dummy Variable
Control Sections=0
Experimental Sections=1

(Instructional Process)cont.

INSI=1
Instructor Dummy Variable
Instructor A=1
Instructor B=0

(Cognitive Achievement)

EXAMAP
Application Component of Common Exam questions

EXAMRU
Recognition and Understanding Component of Common Exam questions

EXAMTT
Total Score on Common Exam questions

PRETCA
Pre Score on Complex Application Component of Test of Understanding in College Economics

PRETRU
Pre Score on Recognition and Understanding Component Test of Understanding in College Economics

PRETSA
Pre Score on Simple Application Component of Test of Understanding in College Economics

PRETUC
Score on Part I, Form A of the Test of Understanding in College Economics

POSTCA
Post Score on Complex Application Component of Test of Understanding in College Economics

POSTRU
Post Score on Recognition and Understanding Component of Test of Understanding in College Economics

POSTSA
Post Score on Simple Application Component of Test of Understanding in College Economics

POSTUC
Score on Part I, Form B of the Test of Understanding in College Economics

(Cognitive Achievement) cont.

%GCCA
((POSTCA-PRETCA)/(11-PRETCA)) · 100

%GCRU
((POSTRU-PRETRU)/(11-PRETRU)) · 100

%GCSA
((POSTSA-PRETSA)/(11-PRETSA)) · 100

%GCTUC
((POSTUC-PRETUC)/(33-PRETUC)) · 100

(Affective Variables)

DISSON
Dissonance: The difference between where a student thinks he ought to rank on exams based on previous experience, and where he actually ranks based on exam scores.

EVALTT
Summated score on 25 item course and instructor evaluation instrument

PREATT
Pre-test of Attitude Toward Economics. Composite includes importance, interest, and intent to take more classes in economics

PREIMP
Importance of economic component of pre-test of Attitude Toward Economics

PREINT
Interest in economic component of pre-test of Attitude Toward Economics

PRESOP
Attitude sophistication component of pre-test of Attitude Toward Economics

POSATT
Post-test of Attitude Toward Economics. Composite includes importance, interest, and intent to take more classes in economics

POSIMP
Importance of economic component of post-test of Attitude Toward Economics

POSINT
Interest in economic component of post-test of Attitude Toward Economics

POSSOP
Attitude sophistication component of pre-test of Attitude Toward Economics

APPENDIX B

SURVEY INSTRUMENTS

ATTITUDE SURVEY UWL/AEI-4

INSTRUCTIONS:

I. Write the following information at the top of an IBM answer form:

Name
Course
Section
Date
Attitude Survey - UWL/AEI-4

II. Enter your Social Security number in the ID block according to your Professor's instructions.

III. Your frank response on each item of this opinion survey will aid the instructor in the improvement of this course.

Please indicate your agreement or disagreement with the first ten statements according to the following scale:

A = Strongly Agree
B = Moderately Agree
C = Neither Agree nor Disagree
D = Moderately Disagree
E = Strongly Disagree

---

1. The economic role of the Federal Government will continue to increase.
2. A "free" economy is necessarily better than a "planned" economy.
3. Economic planning may be entirely consistent with democratic principles.
4. Although the national debt of the United States is large, it is not one of our most serious economic problems.
5. The Federal Government's budget should always be balanced, except perhaps during serious national emergencies.
6. Large military expenditures are not necessary to keep the United States' economy booming.
7. One weakness of a competitive economy is that it does not automatically maximize group or public well-being.
8. The basic cause of poverty in the United States is that the poor do not have the will to better themselves.
9. By far the major cause of inflation in recent years has been excessive wage increases.

(over)

10. The major cause of the economy's production at less than full capacity in recent years has been excessive government control.

11. How would you rank economics in comparison to other subjects you have studied on the basis of your personal interest in the subject?

A. One of the most interesting subjects
B. Among the more interesting subjects
C. Undecided or indifferent
D. Among the less interesting subjects
E. One of the least interesting subjects

12. How would you rank economics in comparison to other subjects you have studied on the basis of its contribution to your general education?

A. One of the most important subjects
B. Among the more important subjects
C. Undecided or indifferent
D. Among the less important subjects
E. One of the least important subjects

13. How would you rank economics in comparison to other subjects you have studied on the basis of its contribution to your occupational preparation?

A. One of the most important subjects
B. Among the more important subjects
C. Undecided or indifferent
D. Among the less important subjects
E. One of the least important subjects

14. Is the knowledge which you obtain from studying economics worth the time and effort that you put into studying the subject?

A. Definitely yes
B. Mostly yes
C. Undecided or indifferent
D. Mostly no
E. Definitely no

15. To what extent are you interested in learning (or learning more) about economics?

A. Very interested
B. Somewhat interested
C. Undecided or indifferent
D. Not too interested
E. Not at all interested

16. To what extent are you interested in taking additional course work in economics?

A. Very interested
B. Somewhat interested
C. Undecided or indifferent
D. Not too interested
E. Not at all interested

17. Do you intend to take additional course work in economics within the next two years?

A. Definitely yes
B. Probably yes
C. Undecided or indifferent
D. Probably no
E. Definitely no

18. What is your present inclination toward recommending a course in economics to a fellow student who has never studied the subject?

A. Definitely would recommend course
B. Probably would recommend course
C. Undecided or indifferent
D. Probably would not recommend
E. Definitely would not recommend

19. Do you agree or disagree with the following statement? "Economic understanding is essential if we are to meet our responsibilities as citizens and as participants in a basically private enterprise economy."

A. Strongly agree
B. Agree
C. Undecided or indifferent
D. Disagree
E. Strongly disagree

20. How would you describe your present attitude toward the subject of economics?

A. Very favorable
B. Mostly favorable
C. Undecided or indifferent
D. Mostly unfavorable
E. Very unfavorable

INSTRUCTIONS:

I. Print the instructor's name, the course number, section, and the semester at the top of the IBM answer form. It is NOT necessary to include your name.

II. This form is being used to evaluate the instructional process and to aid in the determination of faculty merit pay increases. Please do your best to give a considered, objective response to each item.

III. Please indicate your agreement or disagreement with the statements below according to the following FOUR POINT scale:

A if you strongly agree with the item
B if you agree moderately with the item
C if you disagree moderately with the item
D if you strongly disagree with the item

---

1. I would take another course that was taught this way.
2. The instructor seemed to be interested in students as persons.
3. I would have preferred another method of teaching in this course.
4. It was easy to remain attentive.
5. The instructor did NOT synthesize, integrate or summarize effectively.
6. NOT much was gained by taking this course.
7. The instructor encouraged the development of new viewpoints and appreciations.
8. I learn more when other teaching methods are used.
9. The course material seemed worthwhile.
10. More courses should be taught this way.
11. The instructor demonstrated a thorough knowledge of the subject matter.
12. The way in which this course was taught results in better student learning.
13. It was a very worthwhile course.
14. Some things were NOT explained very well.
15. I would prefer a different method of instruction.
16. The course material was too difficult.
17. This is one of my poorest courses.
18. Another method of instruction should have been employed.
19. It was quite interesting.
20. I think that the course was taught quite well.
21. The course content was excellent.
22. Some days I was NOT very interested in this course.
23. It was quite boring.
24. Overall, the course was good.
25. On the basis of the factors considered above, and compared to all other instructors I have had at UW-L, I rate this instructor:
    A. Poor
    B. Below Average
    C. Average
    D. Above Average
    E. Excellent

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